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The introduction of the ascidian *Molgula manhattensis* (De Kay, 1843) into Peter the Great Bay (Sea of Japan)

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Abstract

The occurrence of the solitary ascidian *Molgula manhattensis* (De Kay, 1843) in fouling communities of test plates immersed in the Golden Horn Inlet (Vladivostok port) and in the Rynda Inlet (Russky Is.) of Peter the Great Bay, Sea of Japan, was recorded in 1999. This species became dominant in the fouling community after 4 months of immersion of the test plates.

Key words: ascidian, *Molgula manhattensis*, introduced species, test plates, fouling, Golden Horn Inlet.

Introduction

A scientific team from the Institute of Chemistry (Laboratory of Sea Corrosion) and the Institute of Marine Biology (Laboratory of Shelf Communities) of the Far East Branch, Russian Academy of Sciences, has been studying the effect of various pollutants on the succession of micro-, meio-, and macrofouling in the Golden Horn port for many years using steel and glass test plates (Koryakova *et al.,* 2002). In the course of this investigation in 1999, we noted the first record of occurrence of the introduced solitary ascidian *Molgula manhattensis* (De Kay, 1843) in Golden Horn Inlet (Vladivostok port, Peter the Great Bay, Sea of Japan), on steel test plates. A fouling community dominated by ascidians of this species was also found on test plates immersed in Golden Horn Inlet throughout the summer-autumn of 2000.

Materials and Methods

High-alloy steel H18N10T test plates (80×40×1.5 mm) were deployed in the Golden Horn Inlet (Vladivostok) from June to October, 2000, at 2 m depth, by hanging them, off two ships moored at Berths 44 and 42 in the port (Fig. 1). Simultaneously, control steel test plates were deployed at the corrosion test bench in Rynda Inlet, in water corresponding to that of the open Sea of Japan. In addition, an experiment was conducted in 2000 in order to study the dynamics of settling of juvenile fouling organisms on frosted glass plates at Berths 44 and 42 (Golden Horn Inlet, Vladivostok port) and in Rynda Inlet. Observations of the fouling dynamics were carried out twice a month, and at the same time the glass plates were replaced with new ones. To establish quantitative indices of settled juvenile animals in the biofilm, 10 cm^2 sampling areas were used, and all samples were taken in three replicates. During the semi-monthly changes of plates, water samples were taken from their deployment site to determine the biochemical oxygen demand (BOD_5), pH, and concentrations of three groups of bacteria: saprophytes, oil-oxidizers, and sulphate reducers.

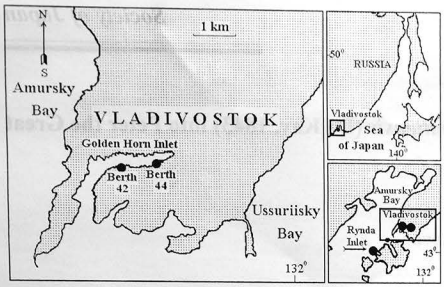

Fig. 1. Map of the study area.

Results

Molgula manhattensis is well known; therefore, we present only a brief description of its morphology for the identification of the species and to distinguish it from other species of this genus.

Class Ascidiacea
Order Stolidobranchia
Family Molgulidae
Molgula manhattensis (De Kay, 1843)
Ascidia manhattensis: De Kay, 1843: 259.
Molgula manhattensis: Van Name, 1945: 385 (and synonyms).
Monniot, 1969: 191 (and synonyms). Kott, 1976: 450; 1985: 379. Abbott & Newberry, 1980: 213.
Vazquez & Urgorri, 1992: 132.

The external appearance of the species is shown in Fig. 2. *Molgula manhattensis* belongs to a group of species characterized by the presence of six branchial folds. There are usually four, and in rare cases five internal longitudinal vessels on each fold. No vessels are found between the folds. A specific feature of this species is a high, twisted gut loop, nearly completely covering the left gonad (Fig. 3). Unlike the closely related *M. tubifera*, male gonads are situated not around the entire right gonad, but mainly along its ventral side. They open in one or two ducts on the left gonad and in four to six ducts on the right one.

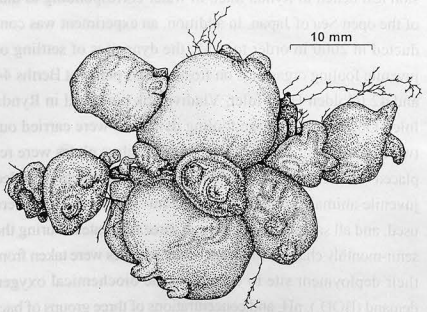

Fig. 2. *Molgula manhattensis*, appearance of a group of specimens.

Hartmeyer (1923) classified several related European and American species belonging to this group under the name *M. manhattensis*, but later it was shown that some of them are independent species (Van Name, 1945 - American species; Monniot, 1969 - European species). Monniot (1969), in his monograph on European molgulids, gave a detailed description of specimens from the Atlantic shores of North America (New York and Chesapeake Bay), as well as of specimens from the Mediterranean Sea and Atlantic shores of Europe. Although there were minor differences in the structure of the specimens he studied, Monniot (1969) considered them as belonging to one species - *M. manhattensis*.

Molgula manhattensis is one of very few ascidian species that can tolerate low salinity, and it may occur in large numbers in closed basins of highly diluted sea water. Water turbidity does not matter much; this species occurs both in clean water and in water with a heavy load of suspended matter. Ascidians of this species are thought to live for about a year; they quickly become sexually mature and reproduce several times during their lifetime. Very small eggs are shed in large quantities directly into the water; for this reason, larvae never occur in the peribranchial cavity. The quick growth of these ascidians can be explained by the very efficient filtration mechanism. The spiral stigmata, high branchial folds, and large number of additional infundibula increase the total filtering surface of the branchial sac.

In fouled steel plates from Rynda Inlet in 1999, several small specimens of *M. manhattensis* were found for the first time in qualitative samples. In fouled plates from Berth 42 in the Golden Horn Inlet, the ascidians of this species had a biomass density of 1.2 kg/m^2, which was 8% of the total for all species on the plates, and a settlement density of 6.7x10^3 ind./m^2.

There was a significant difference in the quantitative parameters of plate macrofouling at Berth 44, situated nearer to the head of the Golden Horn Inlet. In this case, *M. manhattensis* dominated the macrofouling com-

munity (42%), with a mean biomass density of 10.6 kg/m^2 and a settlement density of 11.4x10^3 ind./m^2 (Koryakova *et al.*, 2002: fig. 3). A similar picture was also seen in the fouling of steel plates immersed for 4 months during the summer-autumn of 2000 at Berth 44. The settling dynamics of *M. manhattensis* on glass plates are shown in Fig. 4. Settling of juvenile ascidians was recorded from September to October under a wide temperature range of 13-22°C.

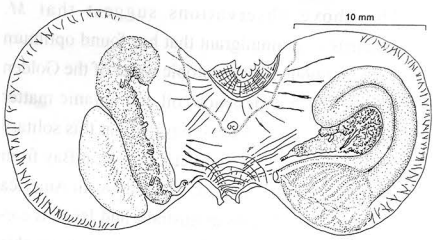

Fig. 3. *Molgula manhattensis,* specimen opened ventrally.

Discussion

The solitary ascidian *M. manhattensis* was recorded by Hentschel (1923) and Visscher (1927) on 7% of surveyed ships based in Germany ports, so the process of its propagation was evidently active even at that time. The settling of this species on glass plates in Beaufort (North Carolina, USA) took place from May through December (Redfield and Deevey, 1957).

The natural distribution of this species seems to be the Atlantic coast of North America, from Maine to Louisiana (USA) (Kott, 1985); however, this species quickly became propagated all over the world. In the 1950's, it was found in large numbers on the Pacific coast of North America in San Francisco Bay (Abbott and Newberry, 1980). According to Japanese specialists (Tokioka and Kado, 1972; Kajihara, 1996), this species was introduced into Japan on ships' hulls. In 1975 it was recorded in Australia (Kott, 1976).

Seasonal settling dynamics of key fouling organisms on test plates in Peter the Great Bay, and in particular in the Golden Horn Inlet, have been studied rather extensively (Gorin and Murakhvery, 1973; Gorin, 1975; Zvyagintsev *et al.*, 1990); however, *Molgula manhattensis* has not been found on these plates until now, nor in fouling communities on ships in the Golden Horn Inlet (Zvyagintsev and Bagaveeva, 1999).

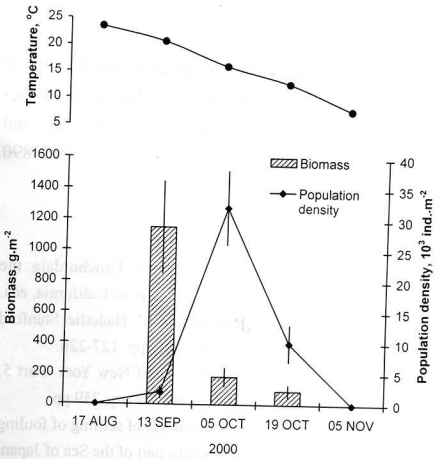

Fig. 4. Settling dynamics of *Molgula manhattensis* on glass plates in Golden Horn Inlet (Berth 44) in 2000. Upper: temperature, lower: 1 - biomass, g/m^2 ± SE; 2 - population density, ind./m^2 ±SE. The error bars were calculated for samples taken in three replicates.

Table 1. Hydrochemical and microbiological characteristics of plate tests areas in 1999 and 2000 (the average means)

Environmental parameters	Rynda Inlet	Golden Horn Inlet, Berth 42	Golden Horn Inlet, Berth 44
O_2 concentration (mg/l)	6.88*		3.88*
	8.88	8.14	7.46
BOD_5	2.57	3.55	3.50
pH value	7.77*		7.0*
	8.44	7.89	7.98
Saprophytic bacterias (1000 cell/ml)	7.7	37.1	63.7
Oil-oxidizing bacterias (1000 cell/ml)	0.9	6.6	14.1
Sulphate reducing bacteria (1000 cell/ml)	6.8	22.6	22.7

* 1999 data

The above observations suggest that *M. manhattensis* is an immigrant that has found optimum growing conditions in the saprobic water of the Golden Horn Inlet, which experiences oil and organic matter pollution (Table 1). If the assumption that this solitary ascidian was introduced into Peter the Great Bay from an original source on Atlantic coast of North America via introduced populations in Australia and Japan is correct, and its capacity for massive propagation in saprobic water is corroborated later on, then it will be possible to use this species as an indicator organism.

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References

Abbott, D. P. and A. T. Newberry (1980). Urochordata: the tunicates. In: Intertidal Invertebrates of California, eds. R. H. Morris, D. P. Abbott and E. C. Haderlie, Stanford University Press, Stanford, Calif., pp. 127-226.

De Kay, J.E. (1843). Natural History of New York. Part 5, Mollusca. New York Assembly, Albany, 259 pp.

Gorin, A. N. (1975). Seasonal dynamics of settling of fouling organisms in the north-western part of the Sea of Japan. In: Fouling in the Sea of Japan and the Okhotsk Sea, ed. G. B. Zevina, FESC AS USSR Press, Vladivostok, pp. 45-70 (in Russian with English summary).

Gorin, A. N. and A. M. Murakhvery (1973). Seasonal dynamics of fouling organisms settling and growth of balanuses in Peter the Great Bay. *Ekologiya*, 2, 86-89.

Hartmeyer, R. (1923). Ascidiacea. Part 1: Zugleich eine Ubersicht uber die arktische und boreale Ascidienfauna auf Tiergeographischer Grundlage. *Danish Ingolf Expedition*, 2(6): 1-368.

Hentschel, E. (1923). Der Bewuchs an Seeschiffen. *Int. Rev. Ges. Hydrol. Hydrogr.*, 11 (3, 4), 238-264.

Kajihara, T. (1996). Foreign sessile animals immigrated into Tokyo Bay. *Mar. Fouling*, 12(2), 25-26 (in Japanese).

Koryakova, M. D., V. M. Nikitin, A. Yu. Zvyagintsev and L. S. Belogurova (2002). Effect of polluted port water on fouling and biocorrosion of steel. *Biol. Morya*. 28(2), 138-142.

Kott, P. (1976). Introduction of the North Atlantic ascidian *Molgula manhattensis* (De Kay) to two Australian river estuaries. *Mem. Qld. Mus.*, 17(3), 449-455.

Kott, P. (1985). The Australian Ascidiacea part 1, Phlebobranchia and Stolidobranchia. *Mem. Qld Mus.* 23, 1-440.

Monniot, C. (1969). Les Molgulidae des mers europeennes. *Mem. Mus. Natn. Hist. Nat.*, 40(4), 172-272.

Redfield, A. K. and E. S. Deevey (1957). Izmeneniya vo vremeni i bioticheskie suksessii [Changes in time and biotic succession]. In: Morskoe Obrasyanie i Borba s nim [Marine Fouling and its Prevention], eds. V. N. Nikitin and N. I. Tarasov, part IV. Voen. Izd. Min. Oborony SSSR Press, Moscow, pp. 68-77 (translated from English).

Tokioka, T. and Y. Kado (1972). The occurence of *Molgula manhattensis* (De Kay) in brackish water near Hiroshima, Japan. *Publ. Seto Mar. Biol. Lab.*, 21, 21-29.

Van Name, W.G. (1945). The North and South American ascidians. *Bull. Amer. Mus. Nat. Hist.*, 84, 1-476.

Vazquez, E. and V. Urgorri (1992). Cinco especies del genero *Molgula* Forbes & Hanley, 1848 (Ascidiacea, Molgulidae) en la ria de Ferrol (no Peninsula Iberica). *Misc. Zool.*, 16, 129-137.

Visscher, J.P. (1927). Nature and extent of fouling of ship bottoms. *Bull. U.S. Bur. Fish.* 43 (2), 193-252.

Zvyagintsev, A. Yu. and E.V. Bagaveeva (1999). Role of anthropogenous substrates in the distribution of species. In: Earth-Water-Humans (Proc. Symp. Earth-Water-Humans, May 30-June 1, 1999, Kanazawa, Japan), eds. K. Tazaki and H. Ikariyama, Kanazawa University Press, Kanazawa, pp.122-128.

Zvyagintsev, A. Yu., A. V. Kurdin, R. N. Metelskaya and G. P. Pukas (1990). Sezonnaya dinamika osedaniya i suksessiya soobshestv obrastaniya v usloviyakh ispytatelynogo stenda [Seasonal dynamics of settling and succession of fouling communities under conditions of test bench]. In: Khorologiya i Sistematika Morskikh Organizmov [Chorology and Systematics of Marine Organisms], eds. V. S. Levin and G. A. Evseev. FESC AS USSR Press, Vladivostok, pp. 101-109 (in Russian).